

CLAIMS

WHAT IS CLAIMED IS:

- 1 1. An accelerated weathering apparatus, comprising:
 - 2 an enclosure having at least one door for access to a test chamber
 - 3 defined within the enclosure;
 - 4 a specimen mounting apparatus disposed within the test chamber for
 - 5 supporting specimen holders;
 - 6 a light source disposed within the test chamber for producing light in the
 - 7 test chamber;
 - 8 a power source for powering the light source;
 - 9 a test module removably disposed in a pocket defined in the at least one
 - 10 door for detecting irradiance in the test chamber produced by the light source
 - 11 and generating an irradiance signal representative of the detected irradiance;
 - 12 a ballast connected to the light source for controlling the amount of
 - 13 power received by the light source from the power source;
 - 14 a controller connected to the test module and the ballast which controls
 - 15 operation of the ballast by transmitting a ballast control signal, whereby the
 - 16 controller adjusts the ballast control signal in response to the irradiance signal
 - 17 received from the test module in order to maintain a desired irradiance within
 - 18 the test chamber; and
 - 19 a calibration module for detecting the irradiance in the test chamber in
 - 20 order to generate and display a reference value which represents the detected
 - 21 irradiance, whereby the calibration module interchangeably replaces the test
 - 22 module in the pocket to detect the irradiance in the test chamber and display
 - 23 the reference value on the calibration module which is inputted to the
 - 24 controller for adjusting the ballast control signal.

1 2. The apparatus as recited in claim 1, wherein the light source
2 includes a plurality of lamps.

1 3. The apparatus as recited in claim 1, wherein the pocket is formed
2 in the at least one door such that a recess is provided on the exterior surface of
3 the at least one door so that the test module and calibration module may each
4 be interchangeably, removably disposed within the pocket when the at least
5 one door is in a closed position.

1 4. The apparatus as recited in claim 1, wherein the light source is
2 selected from the group of lamps that generate ultraviolet light in the UV-A,
3 UV-B, and UV-C ranges.

1 5. The apparatus as recited in claim 1, wherein the calibration
2 module includes at least two internal calibration routines which allow
3 calibration of at least two different types of ultraviolet light while using the
4 same calibration module.

1 6. The apparatus as recited in claim 1, wherein the test module
2 further includes a plug which interfaces with a receptacle disposed in the
3 pocket in order to connect the controller and the test module such that the
4 controller is automatically connected to the test module when the test module
5 is disposed within the pocket.

1 7. The apparatus as recited in claim 1, wherein the test module
2 includes at least one test sensor of an optical photodiode type.

1 8. The apparatus as recited in claim 1, wherein the calibration
2 module includes a reference sensor of an optical photodiode type.

1 9. The apparatus as recited in claim 9, wherein the test sensor has a
2 liner slope of responsivity in the ultraviolet range.

1 10. The apparatus as recited in claim 1, wherein the controller
2 includes a processing unit and memory that stores programming instructions,
3 that, when read by the processing unit, causes the controller to function to:
4 receive a set-point input for the desired irradiance signal; and begin a testing
5 procedure including the steps of: outputting a ballast control signal to the
6 ballast based upon the set-point; receiving the irradiance signal input from the
7 test module; adjusting the ballast control signal based upon gain between the
8 set-point and the irradiance signal; outputting an adjusted ballast control
9 signal; and repeating testing procedure steps for a desired period of time.

1 11. The apparatus as recited in claim 1, further including a
2 temperature sensor connected to the controller for monitoring the temperature
3 within the test chamber, generating a temperature signal, and transmitting the
4 temperature signal to the controller for adjusting the heater control signal in
5 order to maintain the desired temperature within the test chamber.

1 12. The apparatus as recited in claim 1, further including a
2 temperature sensor connected to the controller for monitoring the temperature
3 within the test chamber, generating a temperature signal, and transmitting the
4 temperature signal to the controller for adjusting the ballast control signal in
5 order to maintain the desired irradiance within the test chamber.

1 13. The apparatus as recited in claim 1, wherein the test module
2 amplifies and filters the irradiance signal to reduce frequency noise.

1 14. The apparatus as recited in claim 13, wherein the reduction in
2 frequency noise is achieved by converting a high impedance signal to a low
3 impedance signal with gain.

1 15. An accelerated weathering apparatus, comprising:
2 an enclosure having doors for accessing a test chamber defined within
3 the enclosure;
4 a specimen mounting apparatus disposed within the test chamber for
5 supporting specimen holders;
6 an array of light sources disposed within the test chamber for producing
7 light within the test chamber;
8 a power source for powering the array of light sources; and
9 a plurality of automatically adjustable control channels for sequentially
10 controlling output of the array of light sources, each of the control channels
11 controlling an output of at least one of the light sources, the plurality of control
12 channels including a plurality of test modules removably disposed within
13 pockets defined in the doors and arranged to detect different spatial areas of
14 the specimen mounting apparatus.

1 16. The apparatus as recited in claim 15, wherein each control channel
2 further includes:

3 a ballast connected to at least one of the light sources for controlling the
4 amount of power received by the at least one of the light sources from the
5 power source;

6 a controller connected to the test modules and the ballast for generating
7 a ballast control signal which controls operation of the ballast;

8 a test sensor included with each of the plurality of test modules, the test
9 sensor inserted into an aperture formed in the pocket at a location
10 corresponding to the at least one light source, to detect irradiance in the test
11 chamber produced by the at least one light source, and for generating an
12 irradiance signal representative of the detected irradiance;

13 a transmitting device disposed within the test module connected to the
14 test sensor and the controller for transmitting the irradiance signal to the
15 controller such that the controller may adjust the ballast control signal to
16 maintain the irradiance signal at a desired set point.

1 17. The apparatus as recited in claim 15, wherein there are first and
2 second specimen supporting walls and there are first and second rows of light
3 sources, each row having four lamps.

1 18. The apparatus as recited in claim 15, wherein the plurality of test
2 modules includes four test modules disposed in the pockets such that each one
3 of the four test modules is disposed to substantially select irradiance from two
4 adjacent lamps.

1 19. The apparatus as recited in claim 15, wherein the plurality of
2 control channels including includes four separately adjustable control
3 channels.

1 20. The apparatus as recited in claim 15, further including a
2 calibration module including a reference sensor designed to detect the
3 irradiance inside the test chamber and to generate a reference value
4 representative of the detected irradiance and a reference value display
5 connected to the reference sensor for displaying the reference value which is
6 inputted to the control channels to adjust the output of the array of light
7 sources.

1 21. The apparatus as recited in claim 16, further including a
2 temperature sensor connected to the controller for monitoring temperature
3 within the test chamber, generating a temperature signal, and transmitting the
4 temperature signal to the controller for adjusting the ballast control signal in
5 order to maintain a desired irradiance within the test chamber.

1 22. The apparatus as recited in claim 16, further including a
2 temperature sensor connected to the controller for monitoring the temperature
3 within the test chamber, generating a temperature signal, and transmitting the
4 temperature signal to the controller for adjusting the heater control signal in
5 order to maintain the desired temperature within the test chamber.

1 23. The apparatus as recited in claim 15, wherein the plurality of test
2 modules amplifies and filters the irradiance signal to reduce frequency noise.

1 24. The apparatus as recited in claim 23, wherein the reduction in
2 frequency noise is achieved by converting a high impedance signal to a low
3 impedance signal with gain.

1 25. The apparatus as recited in claim 16, wherein the controller
2 includes a processing unit and memory that stores programming instructions,
3 that, when read by the processing unit, causes the controller to function to:
4 receive a set-point input for a desired irradiance signal; and begin a testing
5 procedure including the steps of:

6 outputting a ballast control signal to the ballast based upon the set-
7 point; receiving the irradiance signal input from the test module;

8 adjusting the ballast control signal based upon gain between the set-
9 point and the irradiance signal;

10 outputting an adjusted ballast control signal; and

11 repeating testing procedure steps for a desired period of time.

1 26. The apparatus as recited in claim 25, wherein the controller
2 includes further programming instructions, that, when read by the processing
3 unit, causes the controller to function to: select one of the control channels for
4 calibration; and begin a calibration procedure including the steps of:

5 disconnecting the test module associated with the selected control
6 channel;
7 connecting a calibration module including a reference sensor with the
8 selected control channel;
9 detecting with the reference sensor irradiance existing in the test
10 chamber substantially due to irradiance produced by the light source
11 associated with the selected control channel in order to generate a reference
12 value;
13 displaying the reference value on a display included with the calibration
14 module;
15 repeating the above steps for each control channel;
16 inputting the reference values into the controller;
17 comparing the reference value associated with each control channel with
18 a set point associated with each control channel; and
19 adjusting a gain for each control channel in order to calibrate the output
20 of the light source associated with each control channel.

1 27. The apparatus as recited in claim 26, wherein the calibration
2 procedure further includes the steps of:

3 detecting with the calibration module for the group of lamps which
4 generate ultraviolet light in the UV-A, UV-B, or UV-C ranges; and
5 communicating automatically the detected lamp to the controller.

1 28. An accelerated weathering apparatus, comprising:

2 an enclosure having at least one door for access to a test chamber
3 defined within the enclosure;

4 a light source disposed within the test chamber for producing light in the
5 test chamber;

6 a power source for powering the light source;

7 a ballast connected to the light source and the power source for
8 controlling the amount of output by the light source from the power source, the
9 ballast including circuitry which controls start-up of the light source such that
10 a low voltage is applied to the light source for a desired period of time in order
11 to warm the light source before igniting whereby shock to the light source is
12 minimized and useful life of the light source is prolonged; and

13 a controller connected to a test module and the ballast which controls
14 operation of the ballast by transmitting a ballast control signal, whereby the
15 controller adjusts the ballast control signal in response to an irradiance signal
16 received from the test module in order to maintain a desired irradiance within
17 the test chamber.

1 29. The apparatus as recited in claim 28, wherein the low voltage is
2 ramped to the light source until reaching operating voltage.

1 30. The apparatus as recited in claim 28, further including a
2 temperature sensor connected to the controller for monitoring temperature
3 within the test chamber, generating a temperature signal, and transmitting the
4 temperature signal to the controller for adjusting the ballast control signal in
5 order to maintain the desired irradiance within the test chamber.

1 31. The apparatus as recited in claim 28, further including a
2 temperature sensor connected to the controller for monitoring the temperature

3 within the test chamber, generating a temperature signal, and transmitting the
4 temperature signal to the controller for adjusting the heater control signal in
5 order to maintain the desired temperature within the test chamber.

1 32. The apparatus as recited in claim 28, wherein the controller
2 monitors the irradiance signal and adjusts the ballast control signal in
3 response thereto in order to maintain the desired irradiance within the test
4 chamber.

1 33. The apparatus as recited in claim 28, wherein the desired period of
2 time is at least approximately 1.5 seconds.

1 34. The apparatus as recited in claim 28, wherein the low voltage is
2 approximately in the range of 2 to 5 volts.

1 35. A method of accelerated weather testing of specimens in a testing
2 apparatus having a test chamber, a specimen mounting apparatus, light
3 sources powered by a power source controlled by a ballast, a plurality of
4 automatically adjustable control channels for sequentially controlling output of
5 the light sources, each of the channels controlling an output of at least one of
6 the light sources, each channel having a test module including a test sensor to
7 detect the irradiance inside the test chamber, the method comprising the steps
8 of:

9 detecting with one of the test sensors irradiance existing in the test
10 chamber substantially due to irradiance produced by the light sources
11 associated with the control channel with which the light source is associated,
12 in order to generate an irradiance signal;

13 transmitting the irradiance signal detected by the test sensor to a
14 controller in the control channel;

15 comparing the irradiance signal with a set-point value to determine if
16 they are equal;

17 adjusting a ballast control signal to the ballast associated with control
18 channel so that the output of the light source is adjusted;

19 repeating the above steps until the ballast control signal associated with
20 each control channel has been adjusted thereby defining a cycle;

21 repeating the above steps for a desired number of cycles;

22 selecting one of the control channels for calibration;

23 disconnecting the test module associated with the selected control
24 channel;

25 connecting a calibration module including a reference sensor with the
26 selected control channel;

27 detecting with the reference sensor irradiance existing in the test
28 chamber substantially due to irradiance produced by the light source
29 associated with the selected control channel in order to generate a reference
30 value;

31 displaying the reference value on a display included with the calibration
32 module;

33 repeating the disconnecting, connecting, detecting and displaying steps
34 immediately above for each control channel;

35 inputting the reference values into the controller;

36 comparing the reference values with the set point values;

37 adjusting again for each control channel in order to calibrate the output
38 of the light source associated with each control channel.

1 36. The method as recited in claim 35, wherein each control channel
2 further includes a temperature sensor connected to the controller for
3 monitoring the temperature within the test chamber, the method further
4 comprising the steps of: generating a temperature signal; and transmitting the
5 temperature to the controller for adjusting the ballast control signal in order to
6 maintain the desired irradiance within the test chamber.

1 37. The apparatus as recited in claim 35, further including a
2 temperature sensor connected to the controller for monitoring the temperature
3 within the test chamber, generating a temperature signal, and transmitting the
4 temperature signal to the controller for adjusting the heater control signal in
5 order to maintain the desired temperature within the test chamber.

1 38. The method as recited in claim 35, wherein the method further
2 comprises the steps of: monitoring the current draw of the ballast; and

- 3 adjusting the ballast control signal in order to maintain the desired irradiance
- 4 within the test chamber.

1 39. A method of accelerated weather testing of specimens in a testing
2 apparatus having a test chamber, a specimen mounting apparatus, light
3 sources powered by a power source controlled by a ballast, a plurality of
4 automatically adjustable control channels for sequentially controlling output of
5 the light sources, each of the channels controlling an output of at least one of
6 the light sources, each channel having a test module including a test sensor to
7 detect the irradiance inside the test chamber, the method comprising the steps
8 of:

9 controlling start-up of the light sources with circuitry in the ballast which
10 applies a low voltage to the light source for a desired period of time to warm the
11 light source before igniting whereby shock to the light source is minimized and
12 useful life of the light source is prolonged;

13 detecting with one of the test sensors irradiance existing in the test
14 chamber substantially due to irradiance produced by the light sources
15 associated with the control channel with which the light source is associated,
16 in order to generate an irradiance signal;

17 transmitting the irradiance signal detected by the test sensor to a
18 controller in the control channel;

19 comparing the irradiance signal with a set-point value to determine if
20 they are equal;

21 adjusting a ballast control signal to the ballast associated with control
22 channel based on the gain between the set point value and the irradiance
23 signal so that the output of the light source is adjusted;

24 repeating the above steps until the ballast control signal associated with
25 each control channel has been adjusted thereby defining a cycle;

26 repeating the above steps for a desired number of cycles;

27 selecting one of the control channels for calibration;
28 disconnecting the test module associated with the selected control
29 channel;
30 connecting a calibration module including a reference sensor with the
31 selected control channel;
32 detecting with the reference sensor irradiance existing in the test
33 chamber substantially due to irradiance produced by the light source
34 associated with the selected control channel in order to generate a reference
35 value;
36 displaying the reference value on a display included with the calibration
37 module;
38 repeating the disconnecting, connecting, detecting and displaying steps
39 immediately above for each control channel;
40 inputting the reference values into the controller;
41 comparing the reference values with the set point values;
42 adjusting again for each control channel in order to calibrate the output
43 of the light source associated with each control channel.

1 40. The method as recited in claim 39, wherein the desired period of
2 time is at least approximately 1.5 seconds.

1 41. The method as recited in claim 39, wherein the low voltage is
2 approximately in the range of 2 to 5 volts.